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HARBOR POLLUTION AND HARBOR DEVELOPMENT

Final Draft

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November 6, 1960

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Some corrections need to be made but they do not change the sense of the Report" — R. H. Cross

"The first [illegible] of ... sanitary [illegible] in [illegible] the urban [illegible] of Boston in the second decade of settlement. On 31 October 1642 it was 'ordered that the Constable shall give speedy notice to Jno. Hach, Butcher, that with all speed he remove the stinking garbage out of his yard, nere the street, and provide some other remote place for slaughter of beasts, that no such loathsome smells might be [illegible], which are of great annoyance unto the neighbors, and to the strangers'..."

"...the mill proprietors... exercised their right to [illegible] the [illegible] mill pond to the [illegible] the Mill Creek... The water in Mill Creek was [illegible] swift flowing, and in [illegible] the drawbridge at North Street was designated as the only place from which butchers might cast 'their beasts entrails and garbidg' without penalty of a fine."

Walter Muir Whitehill
<u>Boston: A Topographical History</u>

SUMMARY AND RECOMMENDATIONS

The present and projected future levels (assuming present collection and treatment policies) of pollution in the harbor impose some constraints on land developments and related activities in the harbor. These few constraints are:

1. Health hazards preclude swimming and shellfish harvesting in some areas. Thus, such activities should not be planned until more detailed engineering studies (followed by the initiation of appropriate action for pollution abatement) have been completed.
2. The sea lettuce problem needs to be considered, and can best be positively avoided by filling or dredging tidal flats adjacent to developed areas. Local experience in the area under consideration can be used as a rough guide to the probable significance of this problem.
3. Oil and debris contamination make an eyesore of the shoreline, and are a detriment to recreational boating and a hazard to swimmers. Large floating debris is a serious navigation hazard.
4. Marinas should be designed so as to allow a high degree of tidal flushing, to avoid local pollution problems arising from the intensive use of pleasurecraft as "summer cottages".
5. Existing sewer outlets and overflows in projected fill areas will have to be located, and appropriate means provided to handle their flow.

At present, many proposals for the abatement of various types of pollution are under consideration, ranging from debris removal studies involving perhaps a few million dollars to a major "deep tunnel" and sewer outfall plan costing over half a billion dollars. While the benefits to be gained from some of the more extensive proposals may not jus-

tify the high costs involved, both the tangible benefits to navigation and the intangible esthetic benefits indicate that existing laws relevant to oil pollution and debris control should be strictly enforced. Moreover, local pollution near the sewage and sludge outfalls may possibly be subject to some reduction through the installation of more effective outfall diffusers. Both the condition of the Inner Harbor areas and the efficiency of the Deer Island plant can be enhanced by carrying out the needed repairs to the Metropolitan Sewerage System, especially the overflow outlets, as outlined in the Camp, Dresser, and McKee report (5).

The abundance of studies and the lack of data encountered during this brief study indicate that further studies should be directed to obtaining accurate, quantitative data. Specifically, the following items need further definition:

1. Pollution sources of the various types need better documentation, including location, type of outlet structure, quantity and quality of effluent, and variations in flow.
2. The assimilation and transport of pollutants in the waters of the harbor need to be determined using appropriate field studies as necessary.
3. Major development projects -- i.e., those which would strongly affect the harbor hydraulics, and thus the distribution of pollutants in the harbor, should be undertaken only after appropriate studies, including perhaps model studies or field tracer studies, have been accomplished.
4. Proper sampling and analysis of the effluent quality from the major outfalls -- Deer Island and Nut Island -- should be done on a continuous basis.

There are, at present, a large number of agencies at various levels of government which are, or should be, concerned with harbor pollution.

A list (probably incomplete) is presented in Appendix A. Clearer lines of responsibility and authority need to be drawn, and better channels of communication established.

The relation between harbor pollution and the introduction of new industries is another aspect of the problem. Aquaculture - the farming of fish and shellfish - is but one example of a new industry that may potentially develop in the harbor. It is difficult to plan for such activities at the present; however, it is important to preserve the options of attracting new industries by preventing extreme - and effectively irreversible - pollution of the harbor.

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Pollution in Boston Harbor and its tributaries has been a serious problem for many years. Only recently, however, has the increased pressure on space near the core city, coupled with a growing concern for the well-being of man's general environment, led to demands that something be done to alleviate the problem.

The reasons for the present condition of the harbor are many, and often obscure. Briefly, the waste disposal systems for the harbor were designed years ago, when the urban population was much less, and when both public opinion and the pollution performance criteria were much more tolerant of pollution. What did it matter if the harbor was polluted? [illegible] Besides, pollution in the harbor didn't greatly affect either the lives of the people of Boston or the industrial activity in the area. In recent years, and especially in the last decade, increasing levels of pollution, in combination with increasing public awareness of the problem, and demands for use of the harbor for recreational purposes, have stimulated a growing concern about harbor pollution.

It is the primary purpose of this investigation to examine the effects that harbor pollution problems may have on the use and development of the harbor space and the adjacent lands. For this purpose, it is convenient to divide the overall pollution problem into three aspects:

1. Direct pollution by untreated or partially treated sewage.
2. Indirect pollution by algae, phytoplankton, and other aquatic growth (sea-lettuce) feeding on the nutrients contained in sewage and treated sewage.

3. Non-sewage pollution, such as oil slicks, debris, and refuse.

Sanitary sewage, raw or partially treated, reaches the harbor by a variety of means, including direct discharge from outfalls at Deer Island and Nut Island; "hidden" outlets from buildings adjacent to the harbor; discharges by and into rivers tributary to the harbor; storm overflows from the combined sewers serving much of Boston and adjacent cities; and malfunctioning combined sewer overflows (many of which continuously discharge fresh wastes into the harbor). The resulting pollution problem consists of:

1. Health hazards, associated with water contact sports. (Note that some virus may survive chlorination of sewage.)
2. Adverse effects on fish, shellfish, and other wildlife.
3. Esthetic pollution -- objectionable odors, sludge deposits, and generally unattractive waters, especially over sewage or sludge outfalls.

Pollution by sanitary sewage, unless gross and malodorous, has little serious influence on land development projects, as evidenced by the high-rise apartments appearing along the waterfront.

Pollution caused by nutrients from treated sewage is another problem. There are presently no economical methods of sewage treatment which remove soluble phosphorus, nitrates, ammonia nitrogen, and certain other inorganic nutrients. These nutrients:

1. cause phytoplankton growth, resulting in greatly reduced dissolved oxygen levels, which adversely affect fish life.
2. encourage the growth of sea lettuce. During low tide, sunlight causes the decomposition of lettuce growing on tidal flats; this decomposition is accompanied by the nauseous odor of hydrogen sulfide, which gas may be evolved in concentrations

large enough to cause discoloration of housepaints. This problem has been serious principally in the Winthrop area, where removal of the adjacent tidal flats by dredging has provided at least temporary relief. (Earlier reports that sea-lettuce growth could be controlled by spreading lime on the tidal flats appear to be misguided.) The possible growth of sea-lettuce in other areas of the harbor is impossible to predict; however, if the nutrient pollution does not increase areas presently free of sea-lettuce are likely to remain so.

Miscellaneous wastes and floating debris are perhaps the most serious problem because their causes are in many cases very difficult to control.

1. Floating oil from accidental spills, transfer activities, etc., coats boat hulls, shoreline structures, etc. In larger concentrations, it adversely affects fish and wildlife. In addition, it has been speculated that the release of oil products, which possibly contain carcinogens, into the marine environment, may cause introduction and concentration of these harmful fractions into the food chain. (1)
2. The larger debris -- logs, timbers, etc. -- presents a serious hazard to navigation.
3. The trash and refuse is unsightly, especially as it collects on shorelines. It can also be a nuisance or hazard to small boats (e.g., ropes fouling propellors, etc.), and a hazard to recreational users of the shoreline.

These last two major categories -- pollution caused by nutrients and by oil and debris -- present the most significant limitations on shoreline development. Two methods would apparently eliminate the sea-lettuce problem. One would be to construct a long outfall that would transport all sewage to a point outside the harbor. The other would be to remove the tidal flats, either by dredging or by landfill. It is not

certain, however, that removal of the tidal flats would be permanent; tidal currents and wave action transporting sediments may cause them to build up again. Problems of oil pollution are easing somewhat, as efforts increase to clean up shipping operations. Substantial control of debris could be effected by strict enforcement of dumping and debris disposal regulations, and by removal of dilapidated shoreline structures and abandoned vessels.

SCOPE OF THE POLLUTION PROBLEM IN BOSTON HARBOR

EXISTING LEVELS OF POLLUTION

A series of measurements by the Federal Water Pollution Control Administration (FWPCA) in July-August, 1967 (2), (3), (4) showed severely degraded water in the downstream reaches of the Charles River, attributed mostly to discharges from combined sewers. (Combined sewers are designed to accommodate both sanitary sewage and storm drainage. Since it would be too expensive to allow for the heaviest rainfalls in the design of the main interceptors and the treatment plants, combined sewers are usually designed with overflow outlets to the rivers or the harbor for the purpose of direct discharge during heavy storms. At such times, some sanitary sewage enters the receiving waters untreated.) Similar problems exist in the Mystic, Malden, Chelsea, Neponset, and Weymouth Fore Rivers. The Chelsea River, moreover, is seriously polluted by oil sludge from oil terminal facilities in the area.

In Boston Harbor proper, direct pollution, as indicated by the presence of more than 100 polychaete worms per square foot of bottom area, was present in about 80% of the harbor (Polychaetes are a type of worm that thrive in water so polluted that few other bottom-dwelling organisms can survive. Generally, the population density of these worms increases with the degree of pollution.) Gross pollution, indicated by a polychaete population of over 1000 per square foot, was present in 30% of the harbor. Figure 1 shows polychaete populations in the harbor.

Under the water quality standards established by Massachusetts, as

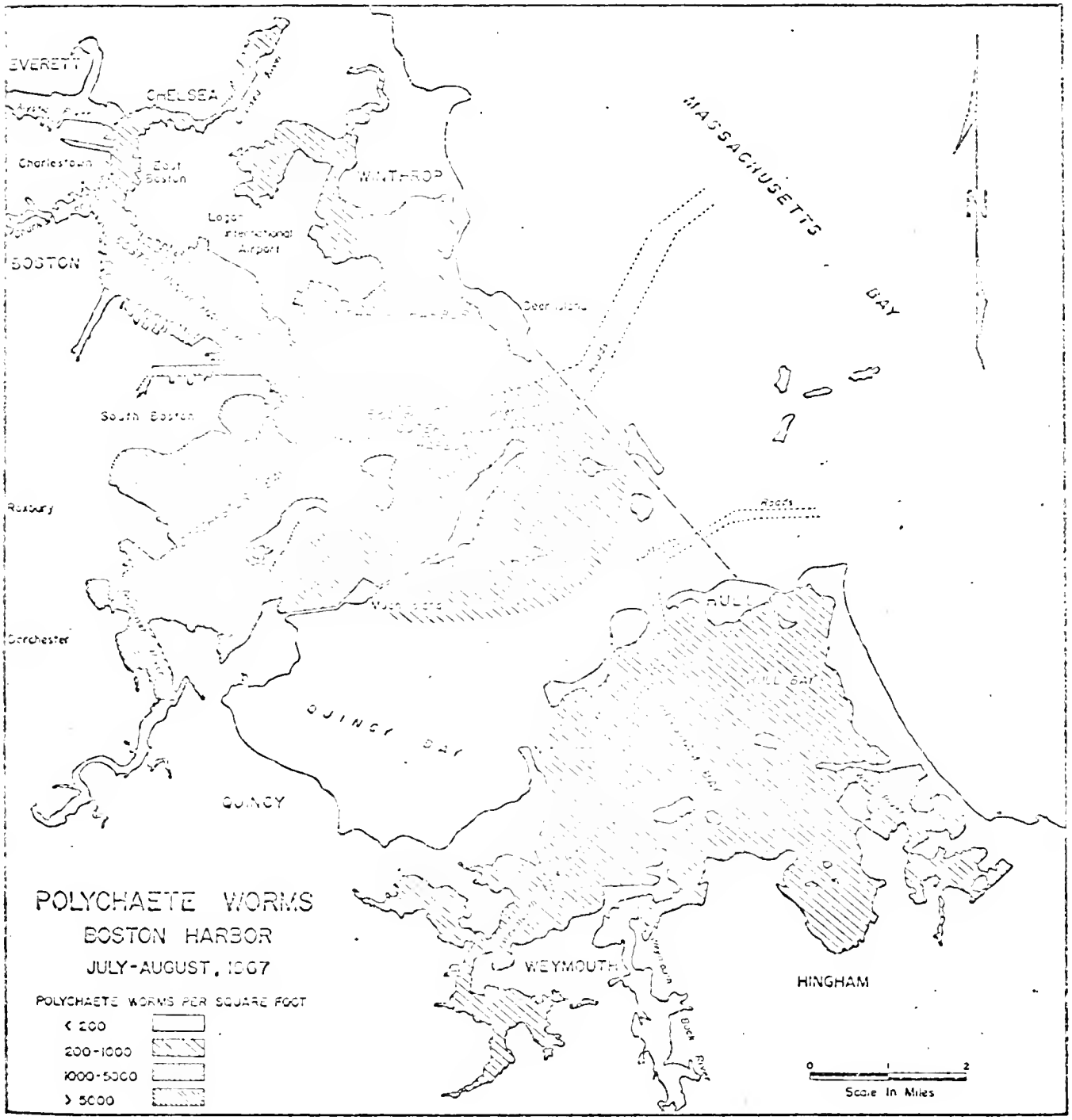


Figure 1

from Pollution of the Navigable Waters of Boston Harbor (FWPCA, 1968)

listed in Reference (4), there were no areas of the harbor which strictly complied with minimum standards of water quality for swimming or recreational shellfishing purposes. In the summer of 1968, however, improvements in the quality of the effluent from Deer Island allowed the opening of several beaches in the southern part of the harbor. Illegal swimming and shellfishing in other areas is accompanied by some risk of disease.

All reaches of Boston Harbor showed excessive concentrations of inorganic nutrients, ammonia nitrogen, and phosphorus.

It must be noted that facilities at Deer Island have only started functioning since the summer of 1967. Thus, the measurements taken at that time probably show the harbor to be considerably worse than it actually is now. (This applies specifically to FWPCA data taken in the Outer Harbor. Several beaches that were not open in 1967 are now open, due to improved water conditions.)

In addition, an increasing number of local problems exist. The Fort Point Channel is polluted to such an extent that it greatly resembles raw sewage. Sludge deposits on the bottom of the channel average about three feet thick, and the organic matter in the sludge decomposes without oxygen. The resulting gases (methane, hydrogen sulfide, etc.) cause occasional large masses of sludge to rise from the bottom.

Some areas of the harbor, of which the Winthrop area is the most outstanding example, have been plagued with the odor and paint discoloration problems associated with the decay of sea-lettuce, which thrives on the nutrients contained in treated sewage. Nutrients are the "end result" of sewage treatment; they cannot be eliminated from the harbor by treat-

ment facilities alone. Complete elimination could only be accomplished by transporting the treated sewage out of the harbor, as through a long ocean outfall. (A ten-mile long outfall serving Nut Island and Deer Island would cost about $100 million. No data are available, however, to show the effects of various outfall lengths.) Efforts are being made elsewhere to combat this problem (for example, in the Oslo Fjord, Norway): efforts should be investigated further. Studies have shown that some of the discharge from the Deer Island treatment plant returns directly to Winthrop Harbor. (6)

Sludge can also be a problem as it is discharged from Deer and Nut Islands (the Nut Island discharge is located in President Roads). Sludge has been observed floating in side areas between Long Island and Deer Island, after discharge, and before it settles to the bottom.

SOURCES OF POLLUTION

The most important contributors of pollution to the harbor are:

1. The outfalls of the Metropolitan Sewerage System treatment plants at Deer Island and Nut Island. The current dry-weather discharge at Deer Island is about 600 cfs; that at Nut Island is about 140 cfs. During rainy weather, the discharge at Deer Island may reach 950-1050 cfs, and that at Nut Island may increase similarly.
2. Combined sewer overflow outlets. An inspection in Boston by Camp, Dresser, and McKee (5) revealed 73 combined sewer outlets (Out of approximately 90 known to exist. The others were not found.), many of which were in the Inner Harbor, or on the far downstream reaches of rivers tributary to the harbor. Of the 73 outlets, 36 were found to be in unsatisfactory working condition; 22 were discharging moderate amounts of raw sewage, and

15 were discharging continuously. It is uncertain how many outlets may have been overlooked by this inspection, because written records of the sewers do not exist in many cases; moreover, there may be roughly the same number of combined sewer overflows in other cities and towns bordering the harbor, and on tributary rivers. Figure 2 shows the dry-weather behavior of the combined sewer overflows found in Boston. Appendix B discusses this problem in more detail.

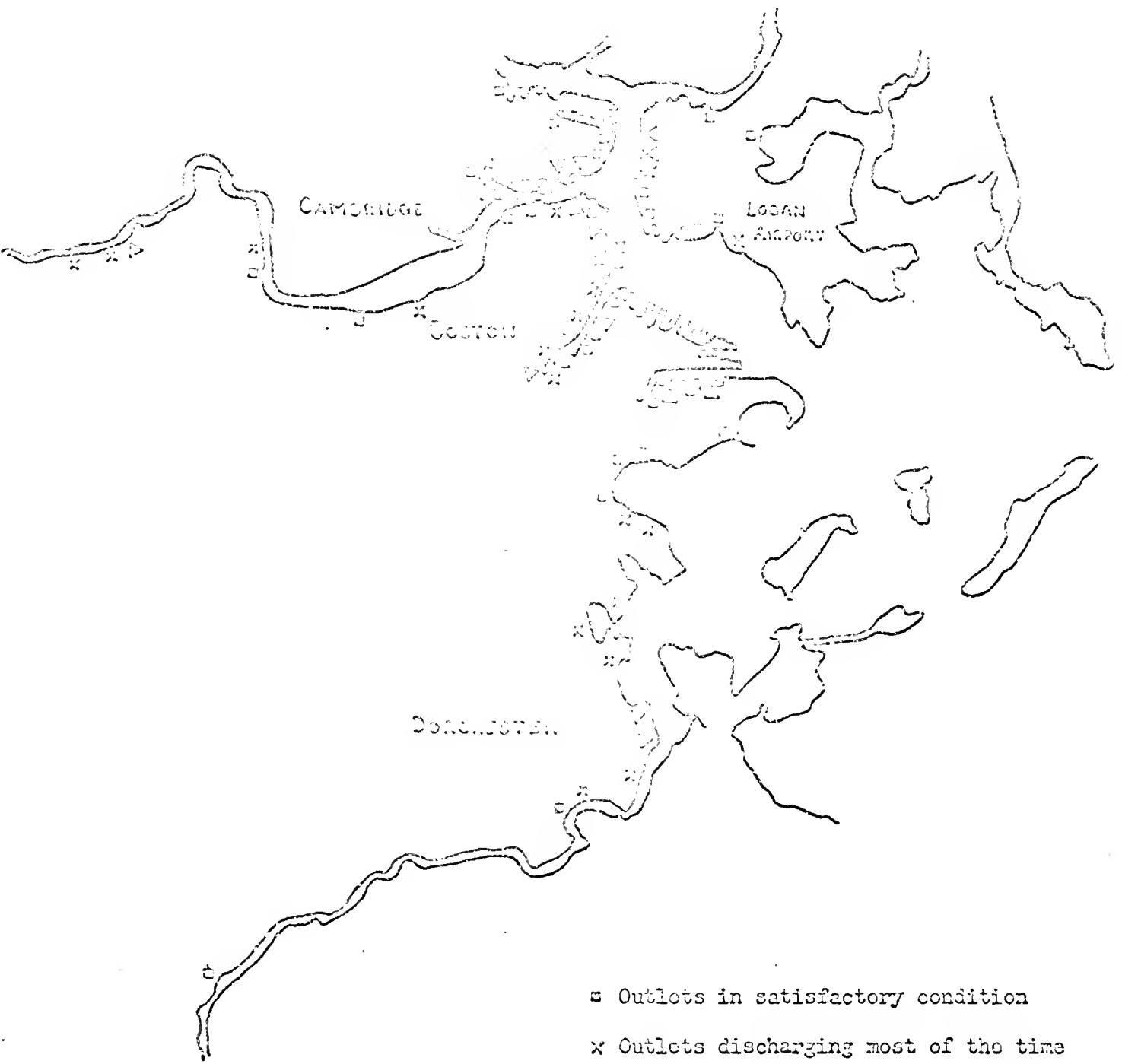
3. Municipal wastes from Hull and Boston. Raw sewage formerly entered the harbor from Moon Head at the rate of about 1.5 cfs. The majority of this flow has been diverted through the Deer Island plant, however, and plans exist to divert the remainder. The Town of Hull still discharges untreated sewage at the rate of about 0.8 cfs into Nantasket Roads. This is a comparatively unimportant amount.

4. Industrial waste discharge. A variety of pollutants are carried into the harbor by water which has been used for industrial cooling, processing, etc. Very little data on industrial pollution is available; however, a study presently underway by the Massachusetts Division of Water Pollution Control should define this source better.

5. Rivers tributary to the harbor. Many towns with combined sewers discharge wastes into tributary rivers. In addition, industrial wastes and spills get into the rivers. Thus, by the time they enter the harbor, many of the rivers have become substantial contributors to pollution.

6. Watercraft wastes. Raw sewage is discharged to the harbor from ships and pleasurecraft. The volume involved may not be critical, but local problems may occur, due to the proximity of these boats to shore. Ways are being sought to deal with sewage from ships, but cost, inconvenience, and lack of federal action toward imposing national standards are important drawbacks. Obviously, Boston cannot independently impose strict

Figure 2. Combined Sewer Outlets in Boston Harbor



▫ Outlets in satisfactory condition

× Outlets discharging most of the time

◿ Outlets discharging all of the time

Data from Camp, Dresser, & McKee report; September, 1967

standards on ships using the harbor without losing much trade to more lenient ports. Wastes from pleasurecrafts are generally minimal, but may become serious problems near marinas. The cost of operating a boat causes many people to use their boats as summer cottages while docked at marinas. The potential for sewage buildup is quite apparent. A Senate document deals with this problem in more detail (10).

7. Oil leakage and small spills. Leakage from oil terminal facilities in certain areas, especially along the Chelsea River, has caused local problems. In addition, accidental large spills occasionally create problems of more consequence. Legislation is now being formulated which should help the situation; in addition, industries seem to be more than normally willing to cooperate on this matter. For example, more than 10,000 feet of plastic boom, purchased by industry, will soon be available for containing spilled oil in the harbor.

   The use of emulsifying agents to disperse spilled oil should be strongly discouraged until the consequences are better understood. While non-toxic agents are available, the biological effects of oil contamination are probably aggravated by using this approach on a regular basis.

In addition to these sources which create waste that dissolves in or mixes with the water, a number of other sources contribute waste that remains separate from the water:

8. Debris and refuse from barge operations. Barging activities associated with the transport and burning of debris from demolition activities introduce substantial amounts of litter to the harbor.
9. Dilapidated piers and wharves, and abandoned vessels. Decaying wooden structures on the shoreline and abandoned sunken vessels shed miscellaneous boards, shingles, and timbers, which can become a distinct navigational hazard when floating in the

harbor. In addition, a great deal of lumber and timbers are dropped into the harbor during demolition of waterfront structures. Much of this debris could be contained by placing a boom around the demolition activities, and then collecting it at the end of operations.

10. Shoreline refuse dumping. Construction firms doing demolition work in the cities often dump their debris on sites adjacent to the harbor, or along rivers. Much of this debris is caught by the tides, and thus enters the harbor. In a similar way, much debris floats away from sites where landfilling is being attempted without adequate diking. Most of this problem could be dealt with by enforcement of existing laws.
11. Miscellaneous debris. Other pieces of small debris are cast into the water by people on boats, at beaches, etc. And of course, garbage and litter which blows around harborside streets is subject to being blown into the harbor.

BOD ENTERING THE HARBOR

Biochemical Oxygen Demand (BOD) is a measure of the oxygen required for the biochemical decomposition of organic materials, and is thus an index of the amount of organic materials present. For fresh water and sewage, moreover, this index is thus an indication of the degree of pollution. BOD measurements are not appropriate for sea water, however, since the marine organisms and other organic matter naturally present obscure the effects of pollution. The effect of BOD is to reduce the dissolved oxygen levels in the receiving water.

5-day, 20° C BOD measurements (The most common measure of BOD; i.e., the amount of oxygen consumed in 5 days at a constant temperature of 20° C. The "ultimate" BOD can be perhaps twice the 5-day, 20° C BOD.) by the FWPCA (3) at the mouths of some tributary rivers were as follows:

Charles River	2.03 mg/l
Mystic River	7.15
Malden River	4.55
Chelsea River	5.41

By way of comparison, "typical" untreated domestic sewage has a BOD of about 200-300 mg/l. Consideration of the flows of the above rivers leads to rough estimate of the BOD flowing into the harbor each day.

River	Dry-Weather Discharge	BOD Discharge (lbs per day)
Charles	100 cfs	1675 lbs
Mystic	50 cfs	2890 lbs
Malden	25 cfs	920 lbs
Chelsea	25 cfs	1060 lbs
TOTAL	200 cfs	6545 lbs

The river discharge estimates are only a crude summary of the hydrological data collected by the US Geologic Survey.

At the present time, the sewage discharged at Deer and Nut Islands has a BOD value of about 100 mg/l. At the rate of 600 cfs, Deer Island therefore discharges about 330,000 lbs/day of BOD. The figure for Nut Island is about 75,000 lbs/day. Although these values far outweigh what the rivers discharge to the Inner Harbor, it must be remembered that the Inner Harbor is a much smaller body of water; hence the effects will be much greater for the same amount of introduced contaminant. Moreover, tidal velocities are less in the Inner Harbor, and the sewage disperses outwardly much more slowly. In addition, there is an unknown BOD load entering the Inner Harbor through combined sewer overflow outlets, and

illicit direct discharges. At present, these flows are impossible to estimate.

Construction and modification of the facilities at Deer Island is still in process. In 1975 it is estimated that the BOD of sewage discharged from Deer Island treatment facilities will be 100-120 mg/l.

DISSOLVED OXYGEN DATA FOR THE HARBOR

Dissolved oxygen, and the dissolved oxygen deficit, are two currently popular measures of the quality of receiving waters, particularly for salt water. The dissolved oxygen deficit in water under a particular set of circumstances (i.e., temperature and salinity), and the amount that is actually dissolved. The deficit arises through the Biochemical Oxygen Demand of the discharged wastes. In the harbor, the saturation value for dissolved oxygen was about 6.2 - 8.8 mg/l in July-August, 1967. Actual dissolved oxygen concentrations ranged between 5.0 mg/l (near the mouth of the Inner Harbor) and 8.7 mg/l (near Peddock's Island and Nantasket Roads). The dissolved oxygen deficit at the 18 harbor stations studied ranged from 0.04 mg/l (Peddock's Island - Nantasket Roads) to 3.32 mg/l (mouth of the Inner Harbor).

One of the criteria in the Coastal and Marine Water Standards of Quality for Massachusetts (reproduced in Reference 4) is the amount of dissolved oxygen. For class SA waters, suitable for any high quality water use activities such as bathing and shellfishing, there must be at least 6.5 mg/l of dissolved oxygen at all times. For class SB waters, suitable for swimming, fishing, and restricted shellfishing, there must be at least 5.0 mg/l of oxygen at all times. For class SC, which is not

approved for swimming or for shellfishing, but which is satisfactory for fin fishing, some industrial uses, and recreational boating, there must be no less than 3.0 mg/l of dissolved oxygen at any time, and at least 5.0 mg/l for at least 16 hours of every 24-hour period. Of the 18 harbor stations studied in 1967, only 7 of them met at all times the dissolved oxygen standards for class SC. There were no stations which met the standards for classes SA or SB.

Dissolved oxygen is an important measure insofar as it deals with the welfare of fish, for example; but the standards as formulated are not wholely satisfactory, as they do not recognize the influence of such variables as temperature and marine organisms on the dissolved oxygen content.

Figure 3 shows dissolved oxygen data for the harbor stations. The figures shown are the averages over the sampling period. Minimum values were significantly lower, usually less than 3.0 mg/l (1967 data).

REAERATION IN THE HARBOR

Oxygen consumed by the various decomposition processes must be returned through aeration in the water, through diffusion from other areas (e.g., the ocean), or through transport seaward by the net freshwater flows (essentially nonexistant here). Excluding all other effects (such as reaeration from plants) the rate of oxygen replenishment from reaeration by the atmosphere can be approximated by:

$$\frac{dC}{dt} = \frac{A}{V} k (C_s - C)$$

where C = oxygen concentration at time t

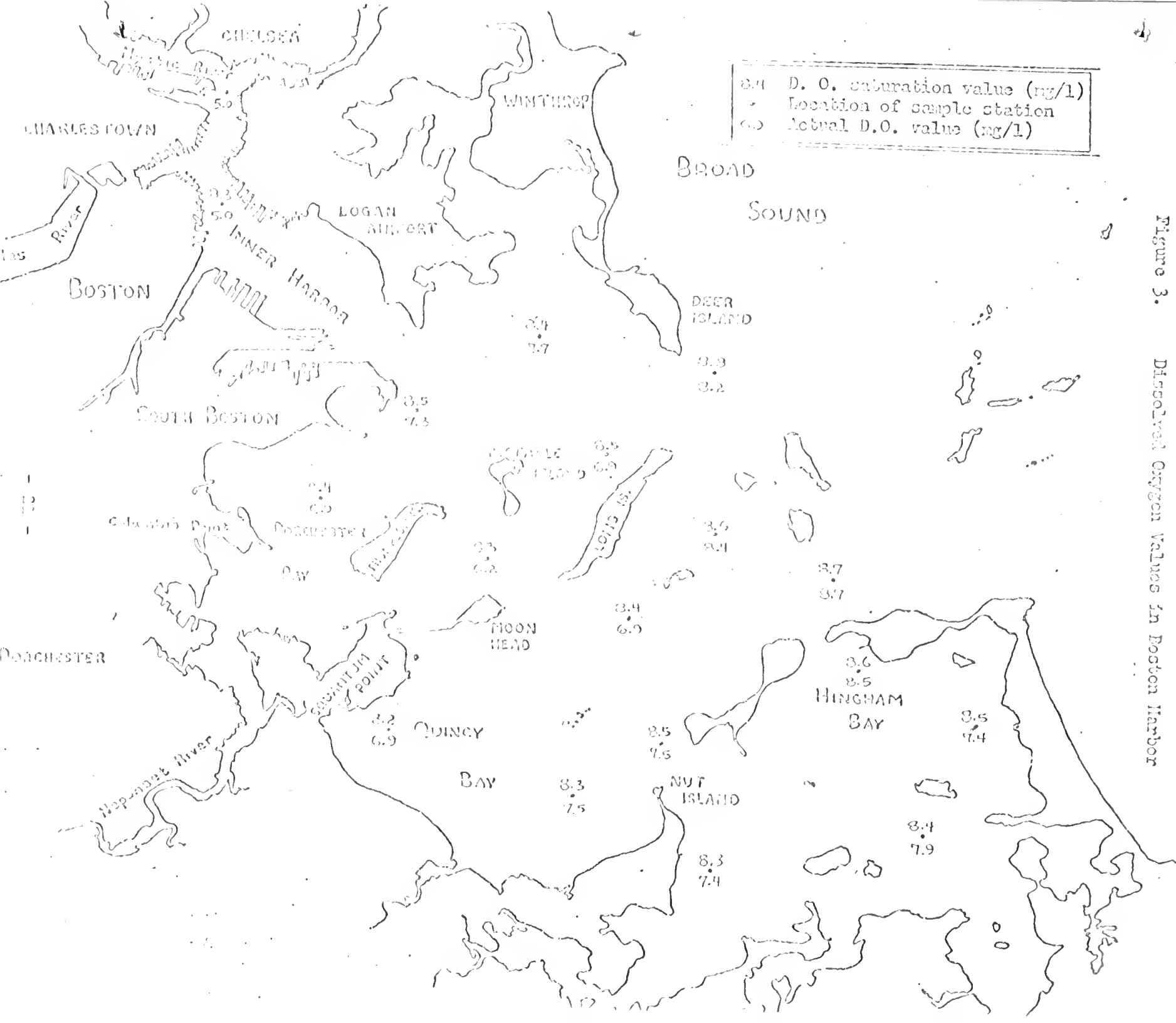


Figure 3. Dissolved Oxygen Values in Boston Harbor

C_s = oxygen saturation concentration

k = diffusion coefficient, = 0.0033 ft/hr for oxygen coming from the atmosphere.

A = area of a given reservoir

V = volume of reservoir

The diffusion coefficient was taken from laboratory studies, and applies to calm conditions. (7) Thus it gives only a very crude (most likely low - probably by an order of magnitude) estimate of the reaeration rate. In addition, phytoplankton contribute oxygen, in unknown quantities.

Reaeration in the harbor was studied by this approximation, simply to gain an idea of the magnitude of the effects which obtain. The four basins studied were Dorchester Bay (the northern third of the harbor), Quincy Bay, Hingham Bay, and the Inner Harbor. The time-averaged rates of reaeration obtained by using the above equation are:

Area	Reaeration Rate (Oxygen Only)
Inner Harbor	2110 lbs/day
Dorchester Bay	283
Quincy Bay	397
Hingham Bay	605
TOTAL	3895 lbs/day

The higher rate of reoxygenation in the Inner Harbor is indicative of the greater dissolved oxygen deficit present there.

Comparison with the daily BOD input of at least 400,000 lbs/day shows that much more oxygen demand flows into the harbor than is likely to be satisfied in the harbor alone. Thus the quality of water in the

harbor depends on the transport of pollutants out of the harbor and the transport of oxygen into the harbor by diffusion associated with the tidal flows. (It must be emphasized that these values only reflect a trend, and represent only gross approximations. Better values could be obtained by using field data to determine the reaeration rate - but this is not a simple process.)

POLLUTION TRANSPORT IN THE HARBOR

Quincy and Hingham Bays are both only slightly polluted; Dorchester Bay, however, is considerably more polluted. Since tidal current charts show that tidal exchange between Dorchester and Quincy Bays, and between Quincy and Hingham Bays is significant, one could estimate the exchange of pollutants between the various bays by establishing water transfer budgets for them. This has been done for all three bays.

Cross-sectional areas of various channels between the bays have been estimated using bathymetric data from USC&GS nautical chart #246. Flows for the channels are calculated on the basis of data given in the USC&GS Tidal Current Charts for Boston Harbor. The channels which have been considered are shown in Figure 4.

If total amount of water flowing in and out of the harbor and the various bays are compared, slight discrepancies will be found. These reflect the limitations of the current data used; these errors, however,

Figure 4. Channels Used in Water Budget Calculations

The following water exchange results were obtained, shown also in Figure 5:

TIDAL VOLUMES PASSING ACROSS VARIOUS CHANNELS (one tidal period)

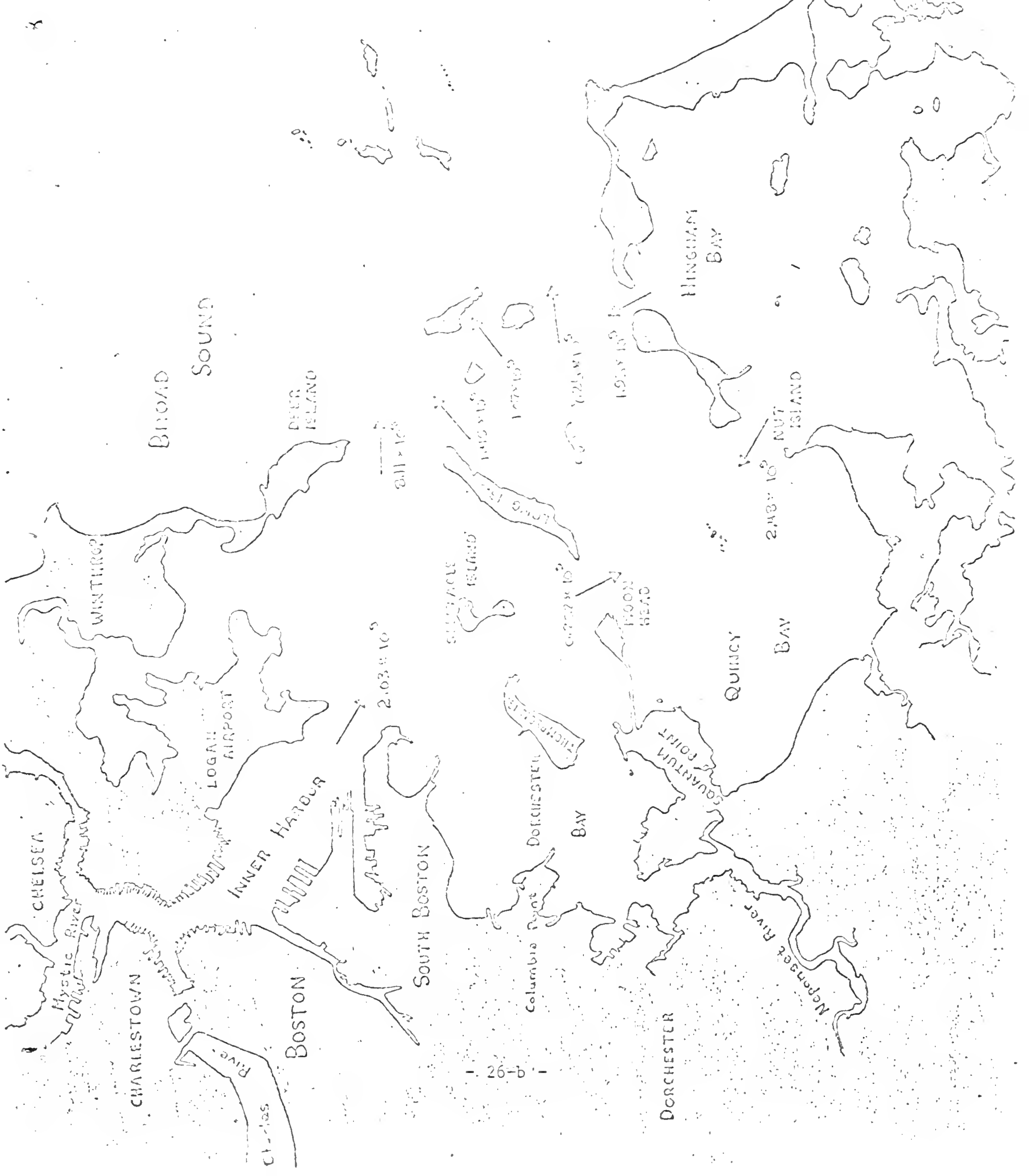
Channel	Number	Cross-sectional area, sq. ft.	Passing volume, flood tide	Passing volume, ebb tide	Net passage for one tidal period
South Boston – Governor's Island	1	88,050	$.76 \times 10^9$ ft^3 northward	2.03×10^9 ft^3 southward	2.7×10^8 ft^3 southward
Deer Island – Long Island	2	186,100	8.22×10^9 westward	8.11×10^9 eastward	1.2×10^8 ft^3 westward
Long Island – Moon Head	3	35,530	$.006 \times 10^9$ southward	$.232 \times 10^9$ southward	2.7×10^8 ft^3 southward
Long Island – Gallops Island	4	41,800	1.62×10^9 westward	1.45×10^9 eastward	1.3×10^8 ft^3 eastward
Gallops Island – Georges Island	5	37,620	1.55×10^9 westward	1.07×10^9 eastward	2.5×10^8 ft^3 westward
Georges Island – Peddocks Island	6	217,000	6.06×10^9 westward	7.25×10^9 eastward	39×10^8 ft^3 eastward
Peddocks Island – Nut Island	7	54,340	2.26×10^9 southeast	2.48×10^9 northwest	2.0×10^8 ft^3 northwest
Peddocks Island – Windmill Point	8	33,400	2.33×10^9 southward	1.93×10^9 northward	4.0×10^8 ft^3 southward

WATER BUDGETS FOR DORCHESTER, QUINCY, AND HINGHAM BAYS (for one tidal period)

	Flood tide	Ebb tide	Net (error)
Dorchester Bay	64.1×10^8 ft^3 in	63.1×10^8 ft^3 out	1.0×10^8 ft^3 in
Quincy Bay	73.1×10^8	70.6×10^8	2.5×10^8 ft^3 in
Hingham Bay	46.1×10^8	44.1×10^8	2.0×10^8 ft^3 in

Figure 5a. Tidal energy flux in Boston Harbor (cubic feet per one foot tide)

Figure 5b. Ebb Tide Water Transport in Boston Harbor
(cubic feet for one ebb tide)



are in all cases less than 5%. Rough estimates have demonstrated that evaporation is not significant over one tidal period.

Using the water exchange data modified slightly from above, as well as figures collected by the FWPCA in 1967 (3), one can calculate the transport of soluble phosphorus, a typical nutrient found in polluted water, through various channels in the harbor. These calculations are subject to some uncertainty, due to the relative paucity of useful data at necessary locations in the harbor. In the mouth of the Inner Harbor and the Deer Island Inlet, calculations have not been made at all, for this same reason. The results of these calculations are shown in Figure 6.

It is significant to study the transport of phosphorus in the harbor, since phosphorus is a relatively conservative component of pollution. Specifically, it is a nutrient which promotes plant growth. The major sources of the nutrient in the harbor are Deer Island and Nut Island, where phosphorus-containing effluents are discharged. Thus, as phosphorus is transported by tidal currents, one can expect all pollutants originating from sewage to be transported. Phosphorus transport thus simply serves as an indicator of pollution, and a tool with which pollution behavior can be estimated. (Of course, other measures besides phosphorus could also be used. It just so happens that in this case, phosphorus measurements are available.) In addition, phosphorus, as opposed to bacteria and other organic matter, is stable enough so that its behavior is not erratic with variations in temperature and other parameters. On the other hand, the amount of phosphorus naturally in sea water

Figure 6. Net Total Phosphorus Fluxes in Boston Harbor
(transport for one tidal period)

is highly variable, and can be of the same order of magnitude as the measured concentrations. Yet, the fact that the estimates made here are based on differences in the average phosphorus levels means that they should be roughly indicative of the actual transport.

Unfortunately, accurate phosphorus figures are not available for the effluent coming out of Deer Island and Nut Island. However, a rough estimate can be made for both of these figures. Since the total phosphorus flux out of Quincy Bay during one tidal period is 9100 lbs, let us assume this is the output of Nut Island. Since Deer Island discharges 600 cfs, whereas Nut Island discharges only 140 cfs, then the amount of phosphorus discharged by Deer Island must be 9100 x (600/140), or 39,000 lbs. Of course, the transport phenomena are more complex in President Roads; however, this phosphorus must eventually be either flushed out to sea, or incorporated into bottom deposits.

In light of these figures, it is apparent that closing the channel between Moon Head and Long Island should not present any great pollution problems, since the total phosphorus flow between these channels is only 1830 lbs per tidal period.

EFFECTS OF POSSIBLE LANDFILL ON THE HARBOR

A number of proposals for the future of Boston Harbor include landfills in the region between Squantum and Long Island, and causeway (both fill and pile-supported) connections between various islands (Figures 7-13). Several of these proposals are examined below. Since it appears most economical to use fill causeways in depths less than 6 ft, and pile

(structural) causeways in greater depths, this practice will be assumed in the following comments.

Proposal 1 involves only filling the gap between Squantum and Thompson Island. Since this area is quite shallow, it is evident that most of the tidal flows into the Neponset River flow through the deep channel north of Thompson Island. Very little effect on the tidal currents and pollution distribution can be expected from the fill.

Proposal 2 involves bridging the channel between Columbia Point and Thompson Island. Since the channel through here is kept at a minimum depth of 12-1/2 ft, much of the causeway would be pile-supported. To minimize excessive tidal currents, the pile-supported portion should include at least 500 ft over the deepest part; the USC&GS Navigation Chart, however, shows a width of approximately 1800 ft between the 6-ft depth contours. Thus, no adverse effects are anticipated, even if this proposal were combined with Proposal 1.

Proposal 3 (and 3a) involve filling most of the shallows in the area between Squantum, Thompson Island, Columbia Point, and the Neponset River. Maintaining an attractive environment would require that the Neponset River be kept clean. In addition, studies of the ecological significance of the fill to the harbor as a whole should be made.

Proposal 4 involves filling the Old Harbor area and (presumably) realigning Carson Beach. No adverse effects are anticipated, with the possible exception of removing a breeding ground for marine organisms.

Proposal 5 involves fill along the southeast side of Moon Head and the fill causeway connecting Moon Head to Squantum. No effects on tidal

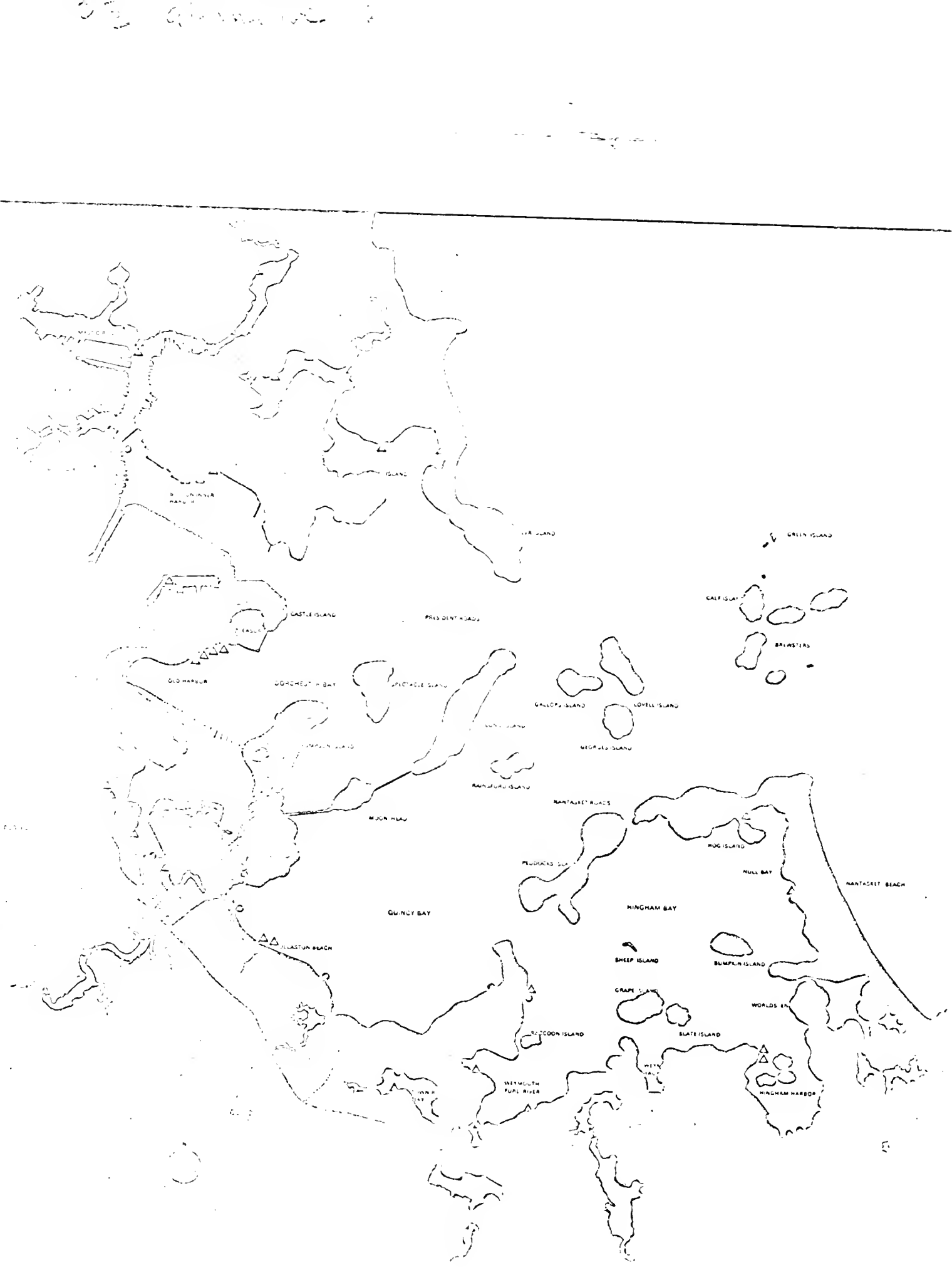
flows or pollution are anticipated, and, if erosion protection is provided, there should be no effect on nearby salt marshes.

Proposal 6 shows various possible locations for structural causeways; since these structures do not impede tidal flows, no adverse effects are anticipated.

Note: These are only
rough sketches
of Figs. 7-12


GREEN ISLAND
BREWSTERS
GALLOPS ISLAND
LOVELL ISLAND
GEORGES ISLAND
RAINSFORD ISLAND
HULL ISLAND
HULL BAY
NANTASKET BEACH
HINGHAM BAY
QUINCY BAY
SHEEP ISLAND
BUMPKIN ISLAND
GRAPE ISLAND
SLATE ISLAND
RACCOON ISLAND
WEYMOUTH FORE RIVER
HINGHAM HARBOR


CASTLE ISLAND
PRESIDENT ROADS
OLD HARBOR
DORCHESTER BAY
SPECTACLE ISLAND
GALLOPS ISLAND
LOVELL ISLAND
GEORGES ISLAND
GREEN ISLAND
CALF ISLAND
BREWSTERS
NANTASKET ROADS
HUGO ISLAND
HULL BAY
NANTASKET BEACH
HINGHAM BAY
QUINCY BAY
WOLLASTON BEACH
SHEEP ISLAND
BUMPKIN ISLAND
RAINSFORD ISLAND
SLATE ISLAND
WEYMOUTH FORE RIVER
HINGHAM HARBOR


GREEN ISLAND
CALF ISLAND
BREWSTERS
CASTLE ISLAND
PRESIDENT ROADS
OLD HARBOR
SPECTACLE ISLAND
GALLOPS ISLAND
LOVELL ISLAND
GEORGES ISLAND
RAINSFORD ISLAND
NANTASKET BEACH
HOG ISLAND
HULL BAY
NANTASKET BEACH
HINGHAM BAY
QUINCY BAY
SHEEP ISLAND
BUMPKIN ISLAND
GRAPE ISLAND
RACCOON ISLAND
SLATE ISLAND
WEYMOUTH FORE RIVER
HINGHAM HARBOR


BOSTON INNER HARBOR
CASTLE ISLAND
DORCHESTER BAY
SPECTACLE ISLAND
GALLOPS ISLAND
LOVELL ISLAND
GEORGES ISLAND
GREEN ISLAND
CALF ISLAND
BREWSTERS
RAINSFORD ISLAND
NANTASKET ROADS
NOSE ISLAND
PEDDOCKS ISLAND
HULL BAY
NANTASKET BEACH
QUINCY BAY
HINGHAM BAY
SHEEP ISLAND
BUMPKIN ISLAND
RACCOON ISLAND
SLATE ISLAND
WEYMOUTH FORE RIVER
HINGHAM HARBOR


GREEN ISLAND
CALF ISLAND
BALLASTERS
CASTLE ISLAND
PHEASANT ROADS
OLD HARBOR
DORCHESTER BAY
SPECTACLE ISLAND
GALLOPS ISLAND
LOVELL ISLAND
GEORGES ISLAND
THOMPSON ISLAND
SUNDAY CAN
RAINSFORD ISLAND
NANTASKET ROADS
HOG ISLAND
HULL BAY
HINGHAM BAY
QUINCY BAY
SQUANTUM POINT
SQUANTUM
SQUANTUM BEACH
SHEEP ISLAND
BUMPKIN ISLAND
GRAPE ISLAND
WORLDS END
RACCOON ISLAND
SLATE ISLAND
WEYMOUTH
FORE RIVER
HINGHAM HARBOR


GREEN ISLAND
BREWSTERS
GALLOPS ISLAND
LOVELL ISLAND
GEORGES ISLAND
HOG ISLAND
HULL BAY
MANTASKET BEACH
HINGHAM BAY
SHEEP ISLAND
BUMPKIN ISLAND
GRAPE ISLAND
SLATE ISLAND
WORLDS END
HINGHAM HARBOR
QUINCY BAY
WEYMOUTH FORE RIVER

1975 PROJECTIONS

Figures have been computed (8) from which the populations of the North and South Metropolitan Sewerage Districts may be projected. The districts are comprised as follows:

North District	South District
Arlington	Ashland
Bedford	Boston (10%)
Belmont	Braintree
Boston (90%)	Brookline
Cambridge	Canton
Chelsea	Dedham
Everett	Framingham
Lexington	Hingham
Malden	Milton
Medford	Natick
Melrose	Needham
Reading	Newton
Revere	Norwood
Somerville	Quincy
Stoneham	Randolph
Wakefield	Stoughton
Wilmington	Walpole
Winchester	Waltham
Winthrop	Watertown
Woburn	Wellesley
	Westwood
	Weymouth

For purposes of estimating sewage flow, 90% of Boston's population may be considered to be in the North District, 10% in the South. A study by Camp, Dresser, and McKee (9) has estimated sewage flows from the various municipalities for 1975. In addition, this study indicates the number of people in each community in 1965 who were connected to the MDC sewerage system. These figures have been used to estimate the sew-

age flow expected in 1975, if all people in the districts were served by sewers. The results are shown below:

Maximum Projected Sewage Flow into Boston Harbor

	1965 Sewage Flow, MGD	1975 Est. Max. Sewage Flow, MGD	% Change
North Metropolitan District (discharges at Deer Island)	158.8*	294.9	+ 85.7
South Metropolitan District (discharges at Nut Island)	112.7	143.7	+ 27.5
	271.5	438.6	61.5

*Deer Island treatment plant not in operation. These sewage flows do not include intrusion by salt water and other non-sewage sources. Current sewage reaching Deer Island is estimated to be 10-20% sea water.

It must be emphasized that these figures give maximum estimates. In the likely event that some individuals are still not connected to the sewers, the figures will be lower. Camp, Dresser, and McKee, for example, have predicted a 16.3% increase for the North Metropolitan District, and a 19.2% increase in the South by 1975 (based on 1965 values). It can be seen that sewage and nutrient levels in the harbor could increase substantially under the present handling and treatment system, if substantial moves are made toward connecting everyone to the MDC sewers. However, in suburban areas of low population density where the water supply is not from indivdual wells, sewage disposal through septic tanks is often an acceptable method, and it is not expected that efforts will be

made to connect the entire population.

ABATEMENT OF POLLUTION

The greatest sources of pollution in the outer harbor are the two MDC treatment plants. In the inner harbor, however, sewage is contributed by many sources; detailed, quantitative information concerning these sources is sorely lacking, and should be obtained.

Several different options are available for pollution abatement. Quantitative predictions on the effects of each cannot be made in the present report, due to a lack of both time and data.

1. Debris and Oil Pollution. Much of the debris problem can be eliminated by (a) removing dilapidated shoreline structures, at a cost of $2-3 million, and abandoned vessels, and (b) strict control of demolition, shoreline dumping, etc. Efforts to control oil spillage are presently underway. The effectiveness of these efforts is not known, particularly in the case of a major spill; however, some improvement is certain to result.
2. Pollution of the Inner Harbor. Combined sewer overflows are the source of a great deal of this pollution. Repairing and improving the existing systems, at a cost of perhaps $100-150 million, should alleviate the situation somewhat, although wet-weather discharges will continue to pollute this portion of the harbor. Strict enforcement of building codes, to eliminate illicit discharges from waterfront buildings, should similarly help. (Activities in this direction are presently underway.) Control of pollution from ships in the harbor would also help; the cost, however, may be prohibitive. To completely clean up the inner harbor, some means of solving the combined sewer problem (as, for example, the proposal by Camp, Dresser and McKee, outlined at the end of this section) must be found. It

is questionable how much money should be spent to clean up the inner harbor (beyond control of oil, debris and illicit discharges, and necessary repairs to the existing sewer systems), as the intense industrial, commercial, and shipping uses of this area preclude recreational activities for safety reasons. Better quantitative data on the pollution sources would be valuable, however, in assessing the effectiveness of abatement measures.

3. Pollution of the Outer Harbor. The principal source of pollution in the outer harbor is from the MDC treatment plants at Nut and Deer Islands. Clearly, any serious plans for pollution abatement must include these facilities. Several options are available.

   a. A variety of alternative means of sludge disposal should be investigated more thoroughly. These could include:

      i. Conversion to soil conditioners (e.g., Milorganite). No cost data available.

      ii. Ocean dumping through an outfall. No cost data available, but the figure would probably be 10-30 million.

      iii. Ocean dumping from barges. This is being practiced in Philadelphia (11), where transportation costs run approximately $400,000 per year for a 150 mgd plant; in Boston, this would scale up to perhaps $1 million per year. Additional investments would most likely be required for sludge holding and processing facilities.

   b. An ocean outfall to discharge the entire effluent from both plants (including the sludge) would cause a significant improvement in the water quality in the outer harbor, especially if the remaining small sources were controlled. The cost for a 10 mile outfall, with connecting links and pumping facilities, has been estimated at $100 million.

   c. The Camp, Dresser and McKee Deep Tunnel Plan, described below, would alleviate the combined sewer problem and discharge all wastes from the MDC system through an ocean outfall. The cost would be approximately $500

million, in addition to the $100-150 million for repairs and improvements to the collection system.

THE CAMP, DRESSER AND MCKEE DEEP TUNNEL PLAN

The engineering firm Camp, Dresser, and McKee has recently finished a study of the Metropolitan System, the purpose of which was to suggest and describe possible improvements to it (5).

The basic problem considered is that sewage and treated sewage are getting into Boston Harbor. Especially serious is the problem of overflow from combined sewers, which serve much of Metropolitan Boston. Even when functioning properly, combined sewer outlets admit untreated sewage to the harbor during storm conditions.

The CDM report mentions four basic plans which deal with this problem:

1. Construct a system of completely separate storm and sanitary sewers. Then no untreated sanitary sewage should reach the harbor.
2. Construct holding tanks for storm overflows from the sewers. The tanks would release flood waters back into the sewers when conditions allowed.
3. Construct chlorination tanks for flood discharges. The flood waters including some sanitary sewage would be chlorinated to destroy bacteria, and then discharged into the harbor system.
4. Construct a series of large tunnels in deep bedrock to transport storm sewage, as well as treated sewage from Deer and Nut Islands, out past the Boston Harbor through a long ocean outfall. These tunnels would carry all runoff from combined sewers in Boston, Cambridge, Somerville, Chelsea,

and Brooklyn, preventing any discharge directly into the Harbor itself.

Approximate costs of the four plans are as follows:

PLAN	INITIAL CONSTRUCTION COST	CAPITALIZED ANNUAL MAINTENANCE COST
1	$550 million	$ 34 million
2	735	99
3	400	133
4	430	66

Plan 1 has the unfortunate drawback of requiring vast excavations in urban streets; moreover, the complex intertwining of sewers, electric lines, and water lines (as well as subway tunnels) at points would make this plan prohibitively difficult. The cost of Plan 2 is especially high. This arises from the large amount of valuable Metropolitan land that would be required. On the other hand, construction of Plan 4 could be accomplished entirely through one access tunnel. Although Plan 3 would destroy bacteria, putrescible organic matter would still be discharged into the harbor. Clearly, Plan 4 is the only alternative which would completely remove all sewage, treated and untreated, from the harbor (except for incidental sources). It also appears to be the least expensive of these four major plans. Consequently, it is the plan recommended by CDM.

CONCLUSIONS

The present level of pollution in the harbor influences potential development of the harbor in the following ways:

1. Swimming and other water-contact recreation is precluded in many areas.
2. Shellfishing is similarly restricted.
3. Potential odor problems, principally due to sea-lettuce, suggests avoiding tidal flats near developments.
4. Oil and debris is unsightly, and a hazard to both navigation and recreation.

Except the above items, pollution in the outer harbor presents no serious limitations on the development of land space within the harbor.

The water and phosphorous budgets analyzed indicate that landfills in the areas outlined will have little overall effect on the pollution of the harbor. Local pollution sources, however, must be accommodated. Marinas present a distinct local pollution problem, and should be designed for adequate flushing.

(1) "Hydrocarbons in Digestive Tract and Liver of a Basking Shark", by Max Blumer, Science, Vol. 156, 1967, pp. 390-391.

(2) Biological Aspects of Water Quality -- Charles River and Boston Harbor, Federal Water Pollution Control Administration, 1968.

(3) Chemical and Physical Aspects of Water Quality -- Charles River and Boston Harbor, FWPCA, 1968.

(4) Report on Pollution of the Navigable Waters of Boston Harbor, FWPCA, 1968.

(5) Improvements to (Boston) Main Drainage System, Vols. 1 & 2, Camp, Dresser, and McKee, Boston, 1967.

(6) "The Sea Lettuce Problem in Boston Harbor", J. Water Pollution Control Federation, Vol. 37, No. 8, August, 1965, pp. 1122-1133.

(7) Water Supply and Waste Water Disposal, by Fair and Geyer, J. Wiley, 1961.

(8) Projected Populations, 1990, Boston Metropolitan Area Planning Council, 1968.

(9) Inventory of Water and Sewer Facilities, Camp, Dresser, and McKee, Boston, May, 1967.

(10) Wastes from Watercraft, Senate Document No. 48, 90th Congress, 1st Session, U.S. GPO, Washington, 1967.

(11) "Sludge Disposal at Sea", anonymous, Civil Engineering, Vol. 38, No. 8, August, 1968. p. 63.

APPENDIX A

AGENCIES INVOLVED WITH BOSTON HARBOR POLLUTION

Following is a list of some of the agencies concerned with Boston Harbor pollution, together with a brief indication of their interests.

Boston Building Department -- sewer connections to buildings.

Boston Fire Department

Boston Harbor Pollution Commission -- an informal group which provides interagency communication on pollution problems in Boston Harbor.

Boston Police Department -- harbor patrols.

Boston Port Authority -- interests in all aspects of harbor development; orientation toward problems of commerce.

Boston Public Health Department -- worked on Fort Point Channel problem.

Boston Public Works Department

Boston Recreation Department -- public beaches.

Coastwise Towing Corporation -- removal of hazardous debris from the harbor under contract from US Army Corps of Engineers.

Federal Water Pollution Control Administration -- interests in all aspects of water pollution study and control, especially in relation to water quality standards and sewage treatment.

Maritime Association of Greater Boston

Massachusetts Department of Natural Resources (Division of Water Pollution Control) -- primary pollution control authority over all surface waters of the state; sets, implements, and enforces water quality standards.

Massachusetts Department of Public Health -- water sampling in harbor; regulation of bathing and shellfishing areas for health reasons.

Massachusetts Department of Public Safety -- helps enforce all laws relating to harbor safety.

Massachusetts Department of Public Works -- control of all construction projects in the harbor; control of dredging and barging activities; supervision of waste transportation and disposal in the harbor; custody of state-owned tidelands.

Massachusetts Petroleum Council -- oil spills.

Massachusetts Port Authority

Massachusetts State Attorney General's Office -- authorized to take legal action against owners of waterfront structures not maintained according to law; legal study of Deer Island treatment plant construction.

Massachusetts State Reclamation Board -- drainage and improvement of low lands; removal of obstructions from rivers and streams.

Metropolitan Area Planning Council -- long-range regional planning and coordination for the Boston Metropolitan Area.

Metropolitan District Commission -- control of Metropolitan recreational facilities and shoreline parks; policing of Metropolitan waters; Sewerage Division operates treatment plants at Deer Island and Nut Island.

New England Interstate Water Pollution Control Commission

New England River Basins Commission -- coordination of projects for development of water and related land resources.

Port of Boston Pilots -- debris.

U.S. Army Corps of Engineers -- jurisdiction over navigable waters.

U.S. Coast Guard -- assistance in the enforcement of federal laws.

U.S. Department of Housing and Urban Development -- implementation of pollution control into urban development projects.

U.S. Department of Health, Education, and Welfare -- protection of shellfish industry, health aspects; protection of recreational water use interests.

U.S. Navy

APPENDIX B

THE COMBINED SEWER PROBLEM IN BOSTON

Much of Boston (and adjacent cities) is served by combined sewers, designed to accept both sanitary and storm drainage. Since it is generally not feasible to design treatment facilities to handle the total flow, controlled outlets are provided, so that while the dry-weather flows (sanitary sewage) are delivered to the treatment plant, much of the combined flow during storms is allowed to overflow directly into the receiving water.

Parts of Boston's sewer system are nearly 100 years old. While it was very satisfactory and quite advanced in design when built, population growth since that time has imposed heavy burdens on the system, and age has caused severe deterioration in the older sections. For example, some sections of tunnel are constructed of brick; these are especially susceptible to collapse.

The major problem lies in the combined sewer outlets, which discharge raw sewage into the Mystic River, Charles River, Neponset River, and Boston Harbor after most periods of precipitation. In addition, many of these outlets do not function properly, and discharge raw wastes even during dry weather. The health hazards associated with the presence of raw sewage in the harbor environment are obvious. (In addition to the areas mentioned, it is probable that other rivers are also contaminated, since combined sewers are not limited to Boston alone.)

Camp, Dresser, and McKee made a survey of the Boston sewer system, and have prepared a report on an inspection of combined sewer outlets (5). This report identifies the location of outlets, and makes note of their general working condition. Of the approximately 90 outlets known to exist in Boston, 73 were inspected. About half were found to be in unsatisfactory condition, i.e., discharging during dry weather.

In order to get a better idea of the conditions indicated by Camp, Dresser, and McKee, a visual inspection of the actual outlets was made. In many cases this inspection was unsuccessful, since many outlets are built to discharge beneath the water surface in rivers, or beneath the low tide level. However, a number of outlets were observed. By far the most flagrant violators of public interest were found on the Charles River. Across from the Northeastern University Boathouse (also Riverside Boat Club) there is a rectangular concrete tunnel about six feet square, which was observed to be discharging raw sewage at a rate of about 2-4 cfs in dry weather. Included in the discharge was a large amount of suspended solids, and considerable floating scum, including decomposed fecal matter. A number of subsequent observations have shown similar discharges at this outlet.

Another outlet discharging large quantities of raw wastes was found on the Charles River at Charlesgate, in the Back Bay. The flow was not fast, but on the other hand, there were three tunnels about

five feet wide, and of unknown depth (probably two-to three feet). Again, the discharge was a cloudy gray, containing considerable suspended matter.

A 16 inch concrete pipe, draining near full capacity into the lagoon by the Hatch Memorial Shell, was probably the most offensive source. Because the river was low at the time of the inspection, the discharge was bubbling out over rocks along the shore. At the time of the inspection, the discharge was extremely malodorous, and contained much suspended matter. The oder of hydrogen sulfide was present for perhaps 100 yards in all directions. As the inspection was being made, a little old lady came walking along. As she approached, she stopped, and then finally asked, "Is that a spring?" (Subsequent inspections have found clear, odor-free water being discharged, but on all occasions the pipe has been discharging near capacity in dry weather.)

Attempts were made to find offending sources along the harbor, but several outlets were not found. Those that were, for the most part, were almost dry. Only two were found that were observed to be discharging any substantial amount of wastes. These were both located in the vicinity of the USS Constitution, in Charlestown.

Discussion of serious problems would not be complete without mention of the Fort Point Channel. At the time of inspection, the Fort Point Channel was not found to be highly malodorous, as has often been reported. It was extremely polluted in appearance, and the waters were

very opaque. And significantly, numerous pieces of fresh (i.e., brown) fecal matter were observed floating on the Channel. Admittedly, this is a very serious situation, and one wonders what the effect would be if some of this fecal matter were to drift by beaches in the harbor. But as a practical consideration, it is probably not necessary to worry about that particular problem. In all probability, the flushing of the Fort Point Channel is probably not great enough to transport the matter out of the Channel; a dead dog that was observed floating at one point in the Channel had been there so long that he (or she) was covered with a generous growth of seaweed.

These observations include only a small number of instances, but they illustrate the problem in a way that statistics cannot. While the expense of cleaning up the inner harbor may not be justified, as the intense industrial and commercial use of the inner harbor precludes many recreational uses, the rivers tributary to the harbor - especially the Charles River - offer many opportunities for recreation, and reducing the pollution level in these rivers would certainly enhance this potential.

APPENDIX C

FURTHER HARBOR POLLUTION STUDIES

Most previous studies of the pollution in Boston Harbor have been concerned only with establishing the degree of pollution present. Once this is established, however, the next logical question is what is to be done about it. Unfortunately, most of the studies have been inadequate to answer the second question.

The basic considerations involved in deciding "what to do about it" are, first, the benefits, both tangible and intangible, associated with different levels of pollution in different areas of the harbor, and, second, the costs of achieving and maintaining those levels. The first consideration is principally economic and social, and beyond the scope of the present report.

In order to evaluate the second consideration, one needs to know the origins of the pollution found at each point in the harbor; then, alternative abatement programs can be evaluated for effectiveness.

While a good deal of the necessary information presently exists, much is still lacking, particularly with respect to the transport phenomena which carry pollutants from the point of discharge to other areas in the harbor.

The first need is for a thorough catalog of pollution sources. Beyond mere identification of these sources, the following information is required:

1. The location, and a description of the discharge structure.
2. The flow rate, and the variation of the flow with time, season,

rainfall, and other variables.

3. The source of the waste, for possible enforcement of pollution abatement regulations.
4. The type and composition of the waste, and the variation with time, rainfall, etc.

In particular, it would be desirable to seek out components of the wastes that are unique to each source, or class of sources, and that can be used as tracers. Temperature differences between waste waters and the harbor waters should be noted, as it may be advantageous to use aerial infrared scanner techniques to locate hidden and submerged discharges.

In order to determine the transport patterns for pollutants from various sources, and the effect of each source on the pollution levels in different areas of the harbor, one has to be able to identify the waste from each source. This is probably best accomplished by some form of tracer, either a component of the waste unique to a particular source or an artificially added tracer. Different tracers should be added to all sources for some time preceding the field sampling program, as well as during the program. It would be wise, however, to collect one set of samples before any tracers are added, to rule out other possible sources of the tracer materials. The field program should be designed with the following points in mind:

1. Discharged wastes are lighter than the sea water in the harbor; thus samples have to be collected at several depths (at least 3 or 4, except in very shallow water) at each station.
2. The distribution of pollutants can be expected to vary with the stage of the tide; thus measurements should be made at least at high water slack and low water slack.

3. The inflow of pollutants is, in some cases, dependent on rainfall; thus the sampling program should include a moderately heavy rainstorm, and preferably two or three of varying intensity.
4. Winds induce surface currents, and thus can be expected to influence the distribution of pollutants; thus the sampling period should include a variety of wind conditions, and the winds present during and before each sampling should be carefully noted.
5. The discharge, etc., from each source can be expected to vary during the sampling period; thus these should be monitored, using recording flow meters and occasional samples for analysis.

Sampling stations should be located throughout the harbor, with a few in the ocean outside the harbor. Since an hour or two of relatively slack water accompanies each change in the tides, one boat can cover several nearby sampling stations.

A careful analysis of the samples collected above will show the concentrations of waste waters from the various sources at different points in the harbor, and thus will give a measure of the benefits to be gained from eliminating each source.

To determine the effects of proposed landfills closing off channels between islands, however, one must ask not only where the pollution from each source goes, but how it gets there. The type of analysis used in the body of this report is appropriate to answer this question; for this purpose, the field program should include samples taken at half-hour to hour intervals in the channels between the islands, and continuing over at least a tidal cycle. If possible, discharge measurements should be

made at the same time, although the USC&GS Tidal Current Charts for Boston Harbor give crude (for the present purpose) data. This approach yields only information on the present role of a given channel in transporting pollutants, and does not account for the changes in tidal flows and transport patterns that would be caused by the proposed fill. With careful interpretation, however, these results can be used as a guide to the probable effects to be expected.

Depending on the success in finding sewage-born tracers, and the degree of accuracy required, such a study would probably cost between $50,000 and $200,000, and take from eight months to a year and a half.

A simpler - and cruder - study can probably be made by comparing the data taken in 1967 by the FWPCA with that taken in 1968. Two factors caused major differences in the sewage inflow to the harbor between the two periods: the large difference in rainfall (and thus combined sewer overflows) and the placing into operation of the Deer Island Treatment Plant. (A careful examination should be made for other differences.) By careful analysis of the differences in pollution distribution for the two summers, it may be possible to gain an improved understanding of the significance of these two sources.

Due to the small additional expense required, a preliminary evaluation of this second study should be begun immediately.

INTER-OFFICE COMMUNICATION

TO

FROM

DATE

SUBJECT

DATE	ISSUED TO

HOUSE No. 5457

The Commonwealth of Massachusetts

INTERIM REPORT

OF THE

SPECIAL COMMISSION

ON THE BOSTON HARBOR ISLANDS

CREATED BY

CHAPTER 86 OF THE RESOLVES OF 1966.

JULY, 1969

BOSTON
WRIGHT & POTTER PRINTING CO., LEGISLATIVE PRINTERS
32 DERNE STREET
1969

The Commonwealth of Massachusetts

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Sen. George V. Kennealy, Jr.
Sen. Mario Umana.
[2] Sen. William D. Weeks.
[2] Rep. Michael F. Flaherty.
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[4] Theodore W. Schulenberg, *Commissioner of Commerce and Development.*
John F. Roman.
[5] Robert H. Quinn.
John M. Moran, *Director and Counsel.*

---

[1] Speaker Bartley replaced former Speaker Quinn upon his election to the office of Attorney General.

[2] Senator Weeks, Representatives Flaherty and Holgate replace Senator Ames and Representatives Donovan and Morrissey respectively.

[3] Representative McGee was appointed under Chapter 112 of 1967.

[4] Commissioner Schulenberg was appointed on September 30, 1968 to replace Kenneth Green who resigned.

[5] Attorney General Quinn was appointed on June 6, 1969 to replace Robert L. Yasi who resigned.

TABLE OF CONTENTS.

The Commonwealth of Massachusetts

SPECIAL COMMISSION ON BOSTON HARBOR ISLANDS,
STATE HOUSE, BOSTON, MASSACHUSETTS, July 8, 1969.

To the Honorable Senate and House of Representatives:

The Commission submits herewith its first report relative to Chapter 86 of the Resolves of 1966: A Resolve providing for an investigation and study by a special commission relative to the construction of bridges, tunnels, causeways, dams and the use of land fill to connect the various islands of the Boston Harbor to each other and to the mainland, and relative to the use and development of lands near the mouth of the Neponset River and on the shores of Dorchester Bay.

A draft of legislation necessary to preserve maximum options in order to continue our investigation is submitted herein.

Respectfully submitted,

JOHN J. MOAKLEY, *Chairman.*
THOMAS W. McGEE.
PAUL MURPHY.
DAVID M. BARTLEY.
MICHAEL F. FLAHERTY.
GEORGE V. KENNEALLY, JR.
PHILIP N. CARNEY.
MARIO UMANA.
EDWARD M. FLANAGAN.
FRANKLIN W. HOLGATE.
JOHN F. ROMAN.

CONCURRING REPORT

JAMES R. McINTYRE.

MINORITY REPORT

JOSEPH E. BRETT.

The Commonwealth of Massachusetts

RESOLVES OF 1966, CHAPTER 86.

RESOLVE PROVIDING FOR AN INVESTIGATION AND STUDY BY A SPECIAL COMMISSION RELATIVE TO THE CONSTRUCTION OF BRIDGES, TUNNELS, CAUSEWAYS, DAMS AND THE USE OF LAND FILL TO CONNECT THE VARIOUS ISLANDS OF THE BOSTON HARBOR TO EACH OTHER AND TO THE MAINLAND, AND RELATIVE TO THE USE AND DEVELOPMENT OF LANDS NEAR THE MOUTH OF THE NEPONSET RIVER AND ON THE SHORES OF DORCHESTER BAY.

Resolved, That a special commission, to consist of five members of the senate, eight members of the house of representatives, the commissioner of public works or his designee, the commissioner of the metropolitan district commission or his designee, the president of the Greater Boston Chamber of Commerce or his designee, the president of the Quincy-South Shore Chamber of Commerce, Inc. or his designee, the chairman of the Quincy Development Commission or his designee, the president of the 1975 World Freedom Fair of Boston, Inc. or his designee, and three persons to be appointed by the governor, is hereby established for the purpose of making an investigation and study relative to the construction of bridges, tunnels, causeways, dams and the use of land fill to connect the various islands of Boston harbor to each other and to the mainland and relative to the use and development of lands near the mouth of the Neponset river and on the shores of Dorchester bay. Said commission shall consider the development and implementation of recreation and conservation programs for the protection and enhancement of the natural characteristics and assets of said harbor and its environs. Said commission shall suggest ways and means for the financing of such developments. Said commission may appoint a person to act as secretary and to correlate its findings, and shall establish his compensation. Said commission may accept and expend gifts and grants of money from the federal government or any other public or private source. Said commission may cooperate with any agency of the commonwealth or its political subdivisions, including regional planning districts in the conduct of its investigation and study, and may enter into cooperative agreements and contracts with said agencies and political subdivisions of the commonwealth for the receipt and expenditure of federal and other grants and gifts, and for professional services, clerical and other services and supplies in connection therewith.

Approved August 15, 1966.

The Commonwealth of Massachusetts

FIRST REPORT OF THE SPECIAL COMMISSION ON THE BOSTON HARBOR ISLANDS.

Introductory Statement.

Boston Harbor, its islands, waters and shoreline constitute an irreplaceable resource that man can either abuse and ultimately destroy or improve, protect and utilize to serve a wide range of metropolitan human needs. No comprehensive estimate of its value as a component of our environment for living is possible. Such values become apparent only as man diminishes them.

This Commission recognizes that the Harbor must be considered as a single body of water, in which changes affecting one part may also affect other parts, and that only on a metropolitan basis can the Harbor, its islands, waters and shoreline be protected and enhanced.

Today the Harbor serves the metropolitan region in a variety of ways. Its waters make Boston both a major seaport and a great airport. It is a vital recreational resource. During the summer of 1970 the number of persons in metropolitan Boston participating in swimming, fishing and boating on an average weekend day has been projected to 330,000 and in the year 2000 some 600,000 people will be trying to be in, on, or at the edge of water on a summer weekend. This figure almost equals the entire present population of the City of Boston. However, the Harbor also functions as the terminus of our metropolitan sewer system. Vast, but undetermined amounts of raw and treated sewage are discharged into the Harbor. For example, the combination of Boston's storm and sanitary sewers, some a century old, dump their contents directly into the waters of the inner Harbor causing serious pollution problems along the bathing beaches in the City of Boston. The pollution would continue even if the storm and sanitary sewer outlets were moved a few hundred feet offshore. According to an estimate of the consulting firm of Camp, Dresser and McKee, the problem could only be solved by an outlay of $442 million for the construction of a deep tunnel system. Another example of sewage discharge into the

Harbor is the 300 million gallons of treated sewage and sludge which the M.D.C. dumps into the outer Harbor daily.

The Harbor can serve human needs to a much greater degree than it does today. Around its shores low-grade commercial and industrial uses can be transformed into residential, recreational, and high-grade commercial uses. New parks, marinas, beaches and fishing facilities could respond to needs for local recreation for the increasing population. A harbor community could provide a wider housing choice, an attractive alternative to suburbia, more employment, increase tax revenues and may aid in understanding our urban problems. But the cost of utilization will be high. Whether recreation or habitation or both, a measure of the costs and benefits must be sought before an intelligent choice can be made.

But the Harbor must be protected now from needless and piecemeal destruction. The Harbor should not be treated as ordinary real estate, available to be filled to create new land. The Harbor should be regarded as the most valuable natural asset of the entire metropolitan region, an essential ingredient contributing to the unique environmental well-being of the area.

Conclusions.

From its investigations and studies to date, the Commission has concluded that:

1. The Harbor is a single body of water the planning of which can be effectively carried out only on a regional basis.

2. The islands, mudflats and shoreline are a basic component of the Harbor, not mere real estate.

3. Priority of uses of the Harbor must be established which provide the greatest public benefit.

4. Careful study must be given to landfill proposals to avoid any alterations which would hamper tidal flushing of pollutants.

5. Water quality must be improved and maintained at levels sufficiently high to permit full public enjoyment and use of the Harbor.

CONCURRING REPORT.

SENATOR JAMES R. MCINTYRE.

As a member of the Harbor Islands Study Commission, established under Chapter 86 of the Resolves of 1966, I concur and endorse the Majority Report of this commission, insofar as it declares that the public has a vital interest in the Harbor Islands and waters of Boston Harbor. It is my belief that the Boston Harbor Islands constitute an unique natural resource of great value for all of the people of the Commonwealth, not only for allowing increased opportunities for public outdoor recreation, including park facilities, new beaches and picnic areas, but also for the purpose of properly conserving and preserving the harbor for open space and historical purposes.

It is interesting to note that most of the Harbor Islands are presently owned by the Commonwealth or her political subdivisions, and in my estimation it is in the distinct public interest at this point immediately to authorize the Department of Natural Resources to acquire all of them into the public domain. This would preface the ultimate absorption of the Boston Harbor Islands under the protection of the Department of Interior of the Federal Government. It is my firm conviction after giving a review of these alternative proposals presented by the Boston Harbor Islands Study Group of Massachusetts Institute of Technology, that the last alternative of developing a new community in the harbor is not a beneficial one to the community I represent and will further complicate the serious transportation problems of the metropolitan area. In fact, it is my opinion that this kind of crass commercial development of Boston Harbor would be inimical to the welfare of the present and future generations of people of the Commonwealth bordering on Massachusetts Bay. Utilization of the harbor to populate Massachusetts Bay more densely in my estimation would be unduly costly and economically unfeasible unless large sums of public monies are expended for site acquisition, preparation and development together with costly but essential transportation connections to the main-

land. The benefit to the existing communities of Massachusetts Bay in my estimation would better result if there were a frontal assault with all available public monies for the alleviation of the complex socio-economic problems of the core cities in the urban congested neighborhoods where people now live, rather than attempted academic experimentation in Boston Harbor with no projected meaningful results.

Respectfully submitted,

JAMES R. McINTYRE,
Senator.

MINORITY REPORT.

JOSEPH E. BRETT, *Representative.*

As a member of the Harbor Islands Study Commission established by Chapter 86 of the Resolves of 1966, I wish to point out that I have been favorably impressed by the work and dedication of the Commission during the past two-and-a-half years and that I am in general agreement with the conclusions and recommendations of the Commission as outlined in the accompanying report and proposed legislation.

In view, however, of my long-standing beliefs and principles that Boston Harbor should be preserved and maintained strictly as a natural resource and used solely for such recreational purposes as are in keeping with the general character of open spaces and natural resources, I object, therefore, to the inclusion of any reference in the report and proposed legislation which suggests the use of the harbor or any of its parts for any purposes other than conservation and recreation.

For examples; I object to the use of such phrases as the following: (1) "A harbor community could provide a wider housing choice, an attractive alternative to suburbia, more employment, increase tax revenues, and may aid in understanding our urban problems" . . . (2) ". . . and for the purpose of providing opportunities for development of maximum public benefit in alleviating the complex social and economic problems to the urban metropolitan area" . . . (3) ". . . and to provide opportunities for housing, education, and employment in order to alleviate the social and economic problems of the urban metropolitan area" . . . (4) ". . . for residential, governmental, recreational, educational, hospital, business, commercial, industrial, or other purposes . . .".

Such phrases destroy the otherwise well-intentioned report of the Special Commission which recommends that Boston Harbor, its adjoining rivers and streams, and all the islands, foreshores, and mudflats therein, shall be acquired by and maintained under the

jurisdiction of the Department of Natural Resources for conservation and recreation uses in keeping with the character of natural resources and open spaces.

RECOMMENDATIONS.

To preserve the widest realm of choice, the commission hereby recommends the following draft legislation to acquire or control the Harbor Islands by the Department of Natural Resources in a land bank under a program of maintenance and improvement pending completion and approval of a comprehensive plan for the harbor.

JOSEPH E. BRETT,
Representative.

PROPOSED LEGISLATION.

The Commonwealth of Massachusetts

In the Year One Thousand Nine Hundred and Sixty-Nine.

AN ACT PROVIDING FOR AN ACCELERATED PROGRAM OF LAND ACQUISITION TO CREATE THE BOSTON HARBOR RECREATION, CONSERVATION, AND DEVELOPMENT PROGRAM.

Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the same, as follows:

SECTION 1. *Declaration of Policy.* — It is hereby declared that the public interest in the islands, shoreline and waters of Boston harbor is in their beneficial use for a variety of purposes; that certain islands, shoreline and conservation lands bordering Boston harbor constitute an unique natural resources of great value to the people of the commonwealth for the purpose of providing increased opportunities for public outdoor recreation close to the heart of a conjested urban area, for the purpose of proper conservation and utilization of natural resources, and for the purpose of providing opportunities for development of maximum public benefit in alleviating the complex social and economic problems of the urban metropolitan area; that the public has an interest in the islands, shoreline and waters as the most valuable single resource of the entire metropolitan area; that the harbor is a single body of water that can be used for many purposes but that the harbor operates as a delicate physical mechanism in which changes that affect one part of the harbor may also affect all other parts.

It is further declared that, unless affirmative action is taken, these objects will not be realized and these lands will become a blighted open-area and detrimental to the safety, health, morals, welfare or sound growth of the area, because the present uneo-

ordinated, haphazard manner in which the islands, shoreline and waters of Boston harbor are being used threatens the natural resource itself and is therefore inimical to the welfare of both present and future residents of the commonwealth; that while some individual projects may be necessary and desirable for the needs of the entire metropolitan area, and while some cities and towns may have prepared detailed master plans for their own harbor lands and waters, the fact remains that no governmental mechanism exists for evaluating individual projects as to their effort on the entire harbor area; that further piecemeal development of the harbor area may place serious restriction on the use of the area, may destroy the irreplaceable feeding and breeding grounds of fish and wildlife in the harbor area, may further adversely affect the quality of harbor waters and even the quality of air in the area, and would therefore be harmful to the needs of the present and future residents of the commonwealth; that it is unduly costly to develop the area soundly through the ordinary operations of private enterprise by reasons of problems of access, by reason of the existence of unsuitable soil or other geologic or physical conditions; by reason of the need for unduly expensive foundations, causeways, retaining walls, or unduly expensive measures for water proofing structures or for filling or draining the area, or for the prevention of the flooding thereof or storm damage thereto, or for unduly expensive measures incident to building around or over rights of way and navigational channels in the area, or for otherwise making the area appropriate for sound development; or by reason of obsolete, inappropriate or otherwise faulty platting or subdivision, deterioration of site improvements or facilities, location of public facilities or operations which by reason of abandonment, obsolescence, present use or otherwise detract from the optimum use of the area, division of the area by rights of way, diversity of ownership and control among public agencies and private owners, or inadequacy of transportation facilities or other utilities; or by reason of the difficulties of development which will not endanger public welfare by harming the ecological values of benefit to the public, or by reason of tax and special assessment delinquencies; or because there has been a substantial change in business or economic conditions or practices, or an abandonment or cessation of a previous use, or by reason of any combination of the foregoing or other conditions.

Therefore, it is hereby declared to be the policy of the commonwealth that certain islands and shoreline in and bordering Boston harbor should be immediately acquired by or transferred to an agency which shall thereafter hold and administer or transfer said lands in accordance with a comprehensive program to be approved by the legislature which shall provide for the realization of these objectives, prevent the creation or continuation of conditions to the detriment of the public, promote the sound growth of the community in order to eliminate substandard conditions and to prevent their recurrence, and to provide opportunities for housing, education and employment in order to alleviate the social and economic problems of the urban metropolitan area. The acquisition of such lands by eminent domain or otherwise, and the planning, clearance, conservation, improvement and rehabilitation of such lands, including disposition in accordance with a comprehensive plan and under such restrictions as will protect the public interest, for residential, governmental, recreational, educational, hospital, business, commercial, industrial, or other purposes, including the provision of streets, parks, recreational areas and other open spaces, are declared to be public uses and purposes for which public money may be expended and the power of eminent domain exercised, and in support of which private property may be regulated by wholesome and reasonable orders, laws and directions.

SECTION 2. *Accelerated Acquisition.* — The department of natural resources hereinafter referred to as the acquiring agency, is hereby authorized to acquire the fee or any lesser interest by gift, purchase or eminent domain under the provisions of chapter seventy-nine or chapter eighty A of the General Laws for the purposes of recreation and conservation under a program described in section five, such islands or portions of islands privately owned as are hereinafter named and such other property as may be necessary or expedient therefore: Thompson, Spectacle, Peddocks, Gallops, Bumpkin, Greater Brewster, Middle Brewster, Outer Brewster, Calf, Little Calf, Green, Raccoon, Hangman, Grape, Slate, Sheep together with islets, rocks, and flats adjacent thereto, provided that existing private uses not inconsistent with the purposes of this chapter may be permitted to continue subject to periodic review.

Said acquiring agency is further authorized to acquire by gift or therewise without cost to the commonwealth, any island, islet, rocks, flat land or portion thereof in Boston harbor owned by any city or town or agency of the federal government.

SECTION 3. *Other Commonwealth Lands.* — The acquiring agency shall designate such lands located in, under or bordering Boston harbor south of a line drawn from Castle island to the neck of Deer island which are owned or under the control of any department, commission or agency of the commonwealth and which are not actually being used as the site of a public facility, such as a park, recreation area, road, school, or sewage disposal site, and said lands shall thereafter be under the control of the acquiring agency for the purpose of this act.

SECTION 4. *Tidelands License.* — No license shall be issued under the provisions of chapter ninety-one for any tidelands bordering on or lands under "Boston harbor south of line drawn from Castle island to the neck of Deer island" without express legislative approval after the recommendations of the acquiring agency.

SECTION 5. *Administration.* — Lands acquired by or transferred to the acquiring agency shall be held and maintained for the purposes of this act under a program of maintenance and improvement pending the completion and approval of a comprehensive plan for the area, and the acquiring agency may expend such sums as may be appropriated therefor.

SECTION 6. *Capital Outlay.* — To meet the expenditures necessary in carrying out the construction and improvements authorized in section Two of this act, the state treasurer shall, upon request of the governor and council, issue and sell at public or private sale bonds of the commonwealth, registered or with interest coupons attached, as he may deem best, to an amount to be specified by the governor and council from time to time, but not exceeding in the aggregate the sum of ten million dollars. All bonds issued by the commonwealth as aforesaid shall be designated on their face, Boston harbor islands Acquisition Act of 1969, and shall be on the serial payment plan for such maximum term of years, not exceeding twenty years, as the governor

may recommend to the General Court pursuant to section three of Article LXII of the Amendments to the Constitution of the Commonwealth, the maturities thereof to be so arranged that the amounts payable in the several years of the period of amortization other than the final year shall be as nearly equal as in the opinion of the state treasurer it is practicable to make them. Said bonds shall bear interest semi-annually at such rate as the state treasurer, with the approval of the governor, shall fix. The initial maturities of such bonds shall be payable not later than one year from the date of issue thereof, and the entire issue not later than June thirtieth, nineteen hundred and ninety-nine. Fifty per cent of all interest payments and payments on account of principal on such obligations shall be paid from the metropolitan district commission funds, to be assessed by methods, fixed by law and the balance shall be paid by the commonwealth.

SECTION 7. *Federal Funds.* — The acquiring agency shall have authority to contract with agencies of federal government for the receipt of funds.

SECTION 8. *Planning.* — The acquiring agency together with the special commission created pursuant to chapter eighty-six of the resolves of nineteen hundred and sixty-six, to make an investigation and study relative to the construction of bridges, tunnels, causeways, dams and the use of land fill to connect the various islands of the Boston harbor to each other and to the mainland, and relative to the use and development of lands near the mouth of the Neponset river and on the shores of Dorchester bay, as most recently revived and continued by chapter five of the resolves of nineteen hundred and sixty-nine or its successor agency shall prepare comprehensive plans to carry out the purpose of this act, may engage such consultants as are necessary, and shall submit the results of its investigation, study and planning to the legislature.

SECTION 9. *Severability.* — The provisions of this act hereby declared to be severable and if any such provision or the application of such provision to any person or circumstances shall be held to be invalid or unconstitutional, such invalidity or unconstitutionality shall not be construed to affect the validity or

constitutionality of any of the remaining provisions of said sections or the application of such provision to persons or circumstances other than those as to which it is held invalid. It is hereby declared to be the legislative intent that said sections would have been adopted had such invalid or unconstitutional provisions not been included therein.

SECTION 10. *Powers of Other Agencies.* — This act shall not be construed to limit the power or authority of any department, board of commission of the commonwealth or of any political subdivision thereof except where expressly provided otherwise herein; provided, however, that in, under or bordering the Boston harbor south of a line drawn from Castle island to the neck of Deer island there shall be no acquisition of land by eminent domain by other than the acquiring agency, and no public land on or bordering said area may be sold, leased or used as a dump or refuse disposal area, and no sand, gravel or soil may be removed therefrom or deposited thereon, and no structure may be built thereon, without the approval of the acquiring agency.

SECTION 11. *Definition of Area.* — For the purposes of this act, Boston harbor shall be defined as the body of water west of a line drawn from Point Allerton in Hull to the Graves light house and south of a line drawn from the Graves light house to the most north westerly point of Deer island and east of a line drawn from the most northwesterly point of Deer island to the most northeasterly point of Castle island. This area includes Boston outer harbor, Dorchester bay, Quincy bay, Hingham bay and Hull bay and including the waters and foreshores of all rivers, creeks and streams flowing into the harbor to the limits of tidal flow and, further, including all islands, mudflats, marshes, and foreshores lying within the area.

INTER-OFFICE COMMUNICATION

TO

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